学校编码：10384　　分类号_____密级_____
学　　号：21620101152288　　UDC_____

厦门大学

硕　士　学　位　论　文

红树植物种子发育过程中 β-胡萝卜素等生理指标的初步研究

The preliminary study of β-carotene and other physiological indicators in the seed development of mangrove plants

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论文提交日期：2013 年 05 月
论文答辩时间：2013 年 06 月
学位授予日期：2013 年　　月

答辩委员会主席：_____
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2013 年 06 月

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摘 要

分别应用高效液相色谱法（HPLC）、蒽酮比色法、3,5-二硝基水杨酸法测定显胎生红树植物秋茄、隐胎生红树植物桐花树和非胎生红树植物无瓣海桑在种子发育的四个阶段（花蕾期、种子期、种子萌发早期、种子萌发晚期）β-胡萝卜素、可溶性糖和淀粉的含量以及 α-淀粉酶活力的变化情况，在实验室前期内源激素测定工作的基础上，进一步探讨红树植物胎生的发生机制。实验结果如下：

1、 三种红树植物繁殖器官不同发育时期 β-胡萝卜素含量的变化：

胎生红树植物与非胎生红树植物繁殖器官在四个发育时期 β-胡萝卜素含量变化显著不同。胎生红树植物从花蕾期到种子萌发晚期表现为先下降后上升的变化趋势，而非胎生红树植物则表现为先上升后下降的变化趋势。其中秋茄在种子萌发早期繁殖器官内 β-胡萝卜素含量最低；桐花树在种子期最低；而无瓣海桑在种子期达到最大值。

2、三种红树植物繁殖器官不同发育时期可溶性糖、淀粉含量的变化：

（1）三种红树植物可溶性糖含量均表现为先上升后下降的变化趋势，且均在种子萌发早期达到最大值。胎生红树植物秋茄和桐花树繁殖器官在四个时期可溶性糖的含量均高于无瓣海桑。

（2）胎生红树植物秋茄和桐花树繁殖器官中淀粉含量表现为一直上升的趋势，在种子萌发晚期达到最大值；而非胎生红树植物无瓣海桑淀粉含量在四个时期差异不大，表现为先上升后下降的变化趋势，并于种子萌发早期达到最大值。

（3）可溶性糖与淀粉的比值变化趋势在三种植物中表现基本一致，即花蕾期和种子期差异不显著，于种子萌发早期达到最大值。秋茄和桐花树在种子萌发晚期比值最小，无瓣海桑在种子期比值最小。

（4）三种红树植物叶片中内可溶性糖、淀粉以及可溶性糖/淀粉比值的比较：显胎生红树植物秋茄叶片中可溶性糖含量远高于隐胎生红树植物桐花树及非胎

生红树植物无瓣海桑，无瓣海桑含量最低；桐花树叶片中的淀粉含量显著高于秋茄与无瓣海桑，无瓣海桑含量最低；无瓣海桑叶片中糖与淀粉比值最高，秋茄次之，。桐花树最低。

3、三种红树植物繁殖器官不同发育时期 α-淀粉酶活力的变化：

三种红树植物 α-淀粉酶活力基本呈现出先上升后下降的变化趋势，均在种子萌发早期达到最大值，其中秋茄和无瓣海桑在花蕾期 α-淀粉酶活力最低，桐花树在种子萌发晚期最低。秋茄叶片中 α-淀粉酶活力在四个时期均为三种植物中最高。

4、三种红树植物繁殖器官不同发育时期含水量的变化：

胎生红树植物在发育过程中繁殖器官内含水量变化不大，均在 60%—80%之间，而非胎生红树植物变化显著，从 75%降低到 45%。秋茄和无瓣海桑在花蕾期最高，于种子萌发晚期最低，桐花树在花蕾期最低，种子萌发晚期最高。

通过上述实验结果，我们初步得出结论，激素含量的变化可能与 β-胡萝卜素含量的变化有关，而激素含量的变化又导致 α-淀粉酶活性、及淀粉和可溶性糖代谢的差异，进而导致胎生的发生。

关键词：红树植物；胎生；种子发育；β-胡萝卜素

Abstract

Using high performance liquid chromatography（HPLC）, anthrone sulfuric acid method and 3,5-dinitrosalicylic acid method, we studied significant viviparous mangrove plant *Kandelia obovata*, hidden viviparous mangrove plant *Aegiceras corniculatum* and nonviviparous mangrove plant *Sonneratia apetala* at their different development periods: flower-bud period, seed period, early germinating period and late germinating period.By observing the content of β-carotene, the content and ratios of soluble sugar and starch, the activity of α-amylase and the moisture content,We attempted to discuss the possible viviparous mechanism further on the basis of the preliminary work of endogenous hormones determination in our lab. Experimental results are showed as follows:

1. Changes of β-carotene content in different developmental stages of reproductive organs of three mangrove species:

Differences in the changes of β-carotene content of the viviparous mangrove plant and nonviviparous mangrove plant are significant during the four stages. For viviparous mangrove species,the trend is decreasing firstly and then increasing,while for nonviviparous mangrove plant the trend is increasing firstly and then decreasing. *Kandelia obovata* has the lowest content in early germinating period,and *Aegiceras corniculatum* has the lowest content in seed period,and *Sonneratia apetala* has the highest content in seed period.

2. Changes of soluble sugar and starch contents in reproductive organs of three mangrove species in different developmental stages:

   (1) For three mangrove species, the changing of the soluble sugar has the same trend:increases firstly and then decreases,and they all have the

highest content in early germinating period.The soluble sugar content of *Kandelia obovata* and *Aegiceras corniculatum* is much higher than *Sonneratia apetala* in four developmental stages.

(2) For viviparous mangrove species:the trend of starch content is increasing during the four stages,and the content is highest in late germinating period.The difference of starch content of *Sonneratia apetala* in reproductive organs of the four periods is not significant. The content of *Kandelia obovata* and *Aegiceras corniculatum* is higher than *Sonneratia apetala.*

(3) For three mangrove specie, the changing of the ratio of sugar/starch has the same trend:the difference of flower-bud period and seed period is not significant and the ratio comes to the maximum in early germinating period. *Kandelia obovata* and *Aegiceras corniculatum* have the lowest ratio in late germinating period,and *Sonneratia apetala* has the lowest in seed period.

(4) The comparison of soluble sugar, starch and the ratio of sugar/starch in leaves of three mangrove species is showed as follows: The soluble sugar content in leaves of significant viviparous mangrove plant *Kandelia obovata* is much higher than hidden viviparous mangrove plant *Aegiceras corniculatum* and nonviviparous mangrove plant *Sonneratia apetala,*and *Sonneratia apetala* has the lowest.The starch content in leaves of *Aegiceras corniculatum* is much higher than *Kandelia obovata* and *Sonneratia apetala,and Sonneratia apetala,*and *Sonneratia apetala* has the lowest.The ratio in leaves of *Sonneratia apetala* is the highest, *and* followed by *Kandelia obovata*, *and Aegiceras corniculatum* has the lowest.

3. Changes of α-amylase activity in reproductive organs of three mangrove species in different developmental stages:

   Generally speaking, for three mangrove species, the changing of α-amylase activity has the same trend: increases firstly and then decreases,and comes to the maximum in early germinating period. *Kandelia obovata* and *Sonneratia apetala* have the lowest in flower-bud period,and *Aegiceras corniculatum* has the lowest in late germinating period. *Kandelia obovata* has the highest of three plants in four periods.

   4 Changes of moisture contents in progenitive organs of three mangrove plants:

   The changes of water content in progenitive organs in viviparous mangrove plant is not significant,all between 60% and 80%,while is significant in nonviviparous mangrove plant, reduces from 75% to 45%. *Kandelia obovata* and *Sonneratia apetala* have the highest content in flower-bud period,and the lowest in late germinating period. *Aegiceras corniculatum* has the lowest in flower-bud period and highest in late germinating period.

Through the above experimental results，we preliminarily concluded that changes in hormone content may be caused by the changes of the β-carotene content. Hormone Variation lead to α-amylase activity and starch and soluble sugar metabolism differences, which might led to the occurrence of viviparous.

Key words: Mangrove plants; Viviparity; Seeds development; β-carotene.